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The impact of sampling regime on the accuracy of water quality status classifications under the Water Framework Directive

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Collaborators

- Data collected under the EPSRC funded LIMPIDS Project
  - University of Reading
    - Andrew Wade; Richard Skeffington
  - Centre for Ecology and Hydrology
    - Mike Bowes, Emma Gozzard, Liz Palmer-Felgate, Jonathan Newman, Helen Jarvie
  - Environment Agency
    - Matt Loewenthal
- Analysis done under the NERC funded Turf2Surf Macronutrients project

UK Implementation of WFD

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- Target = Good Ecological Status/Potential by 2015 (*2027*)
- Ecological status is determined by the worst scoring element
    - Physicochemical Quality
    - Biological Quality
    - Hydromorphological Quality
    - Chemical Quality
- Work is ongoing to improve the WFD targets so that they better relate to ecological quality

UK Implementation of WFD

- WFD targets are based on system typology
  - Lowland: ≤ 80 meters
  - High alkalinity: ≥ 50 mg $CaCO_3$ l^{-1}
- Current WFD Physicochemical Targets:

Determinand	Units	Measure	High	Good	Moderate	Poor
Phosphorus	mg P l^{-1}	Mean reactive P	0.036	0.069	0.173	1.003
			~~0.050~~	~~0.120~~	~~0.250~~	~~1.000~~
Dissolved oxygen	% Sat.	10th percentile	70	60	54	45
Temperature	°C	98th percentile	20	23	28	30
Ammonia	mg N l^{-1}	90th percentile	0.3	0.6	1.1	2.5
pH		Percentile	5th >= 6.0 95th <= 9.0		10th >= 4.7	10th >= 4.2

UK Implementation of WFD

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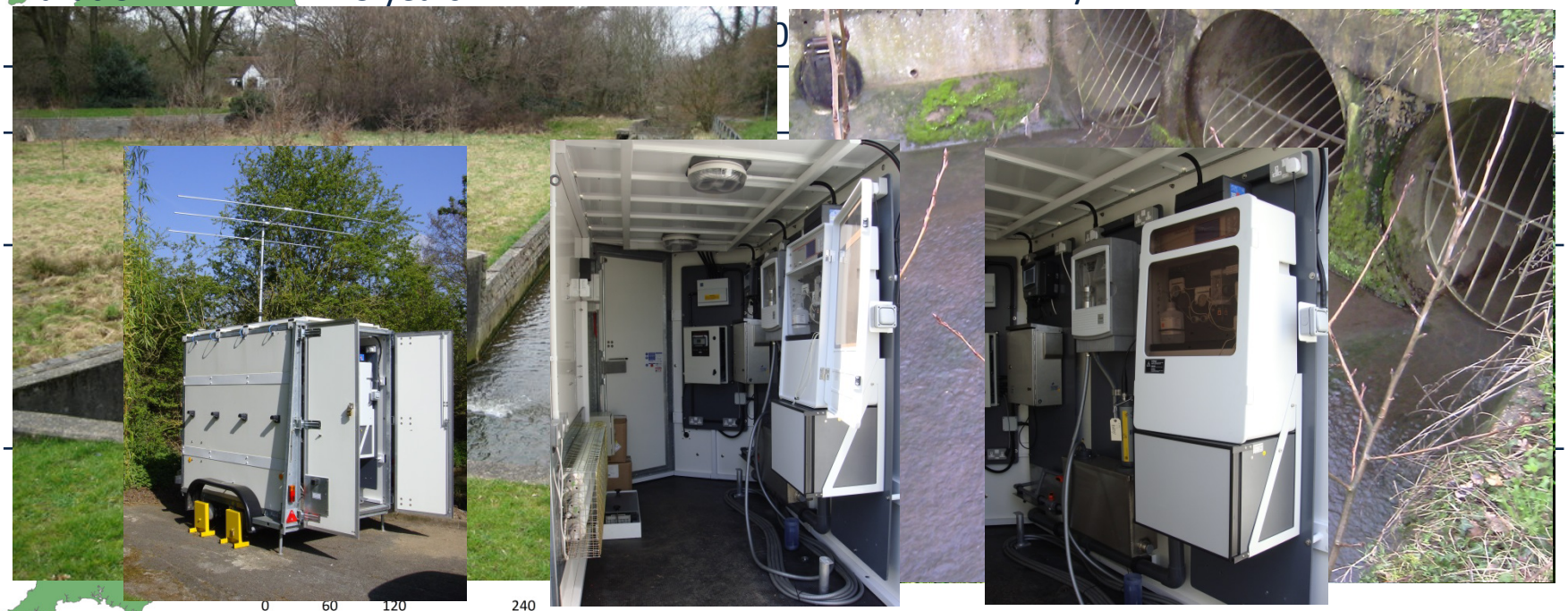
- Targets based on annual datasets
- No guidelines on when or how frequently samples should be collected
  - Status is mostly determined from traditional low frequency datasets (weekly – monthly)
- No guidelines on how regulatory agencies can to use annual targets to:
  - Interpret the meaning of grab samples; or
  - Identify periods of 'potential ecological risk' (PER) from the grab samples

Study Sites

	Enborne ✚	The Cut ★
Catchment	148 km^2 Clay capped Agricultural 6 sewage treatment works (PE: 11,360) 163 registered septic tanks	124 km^2 Augmented flows Urban system 4 STWs (PE: 190,000) 110 registered septic tanks
Duration	2.3 years	1.8 years



Target Specification

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- P targets are specified in terms of “reactive P”
  - Two measures of reactive P
    - Method: Phosphomolybdenum blue colorimetric determination
      - Total reactive P = Unfiltered sample
      - Soluble reactive P = Filtered sample
  - Guidelines state: “… the difference between RP and SRP is ***usually minor***”
- Targets are specified in terms of annual means
  - Growing season (April to September inclusive) means were considered
  - Conclusion: Growing season mean ***largely consistent with or lower*** than annual means

Enborne P Status

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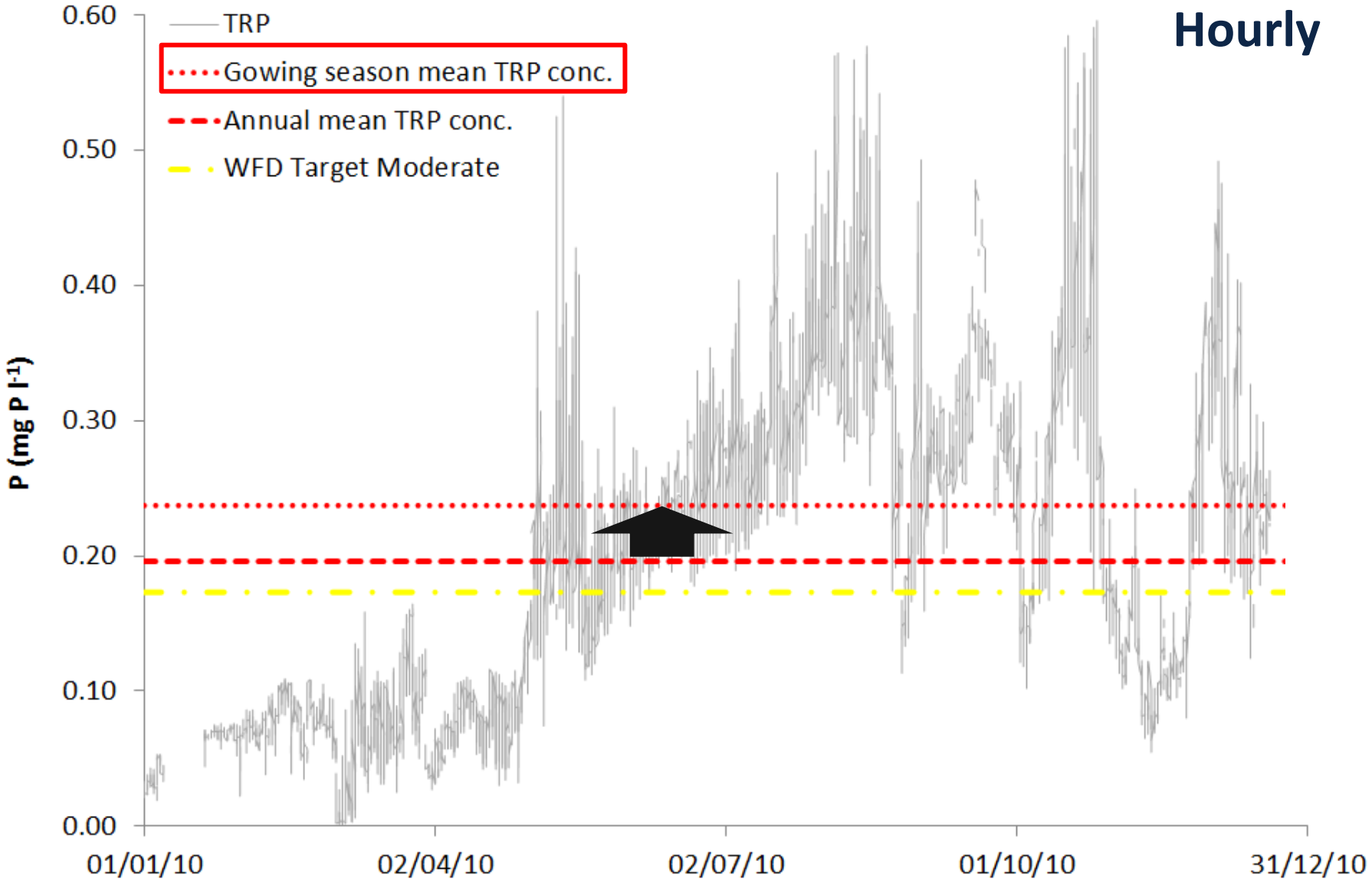

Cut P Status

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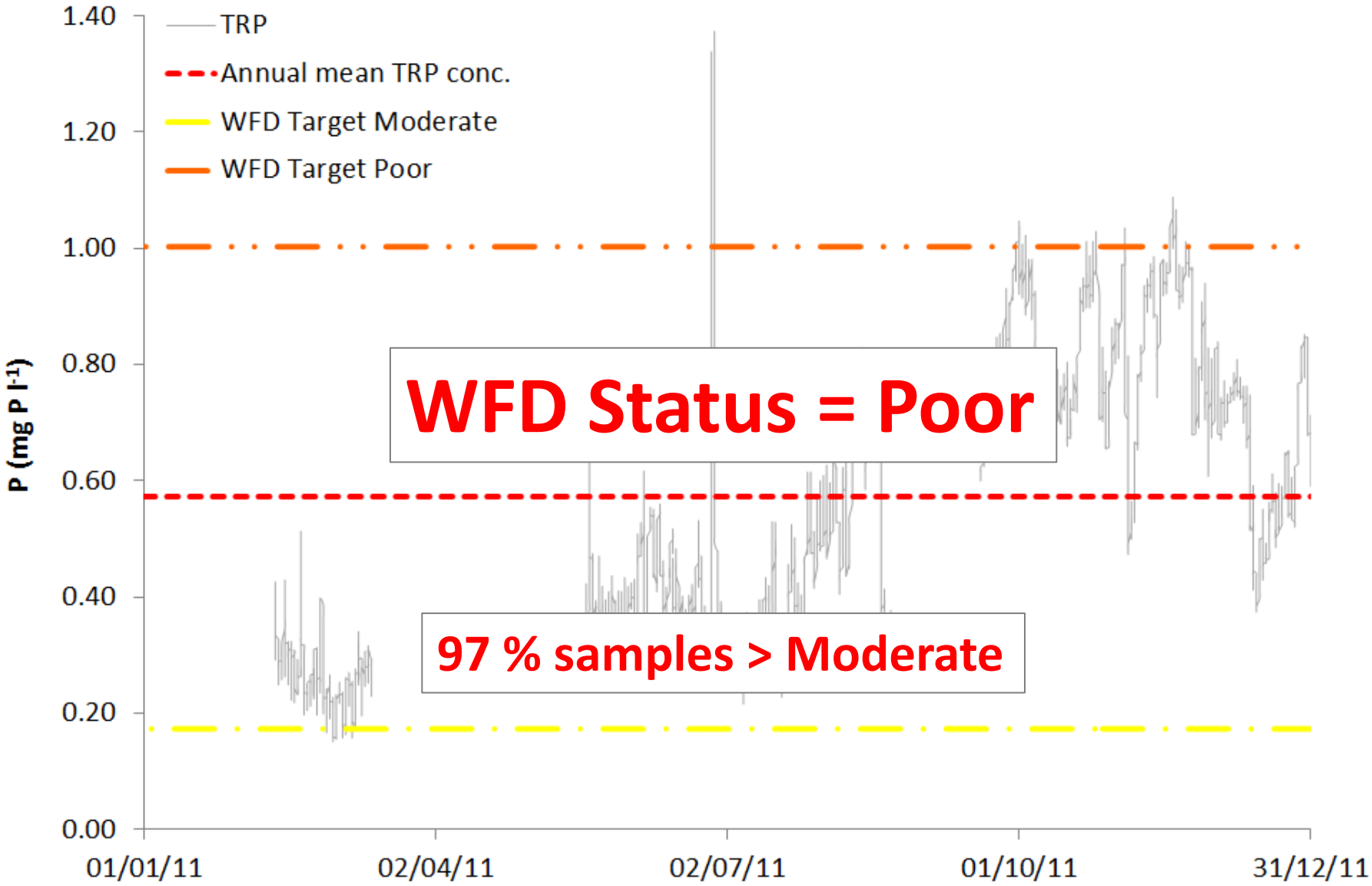

Dissolved Oxygen Status

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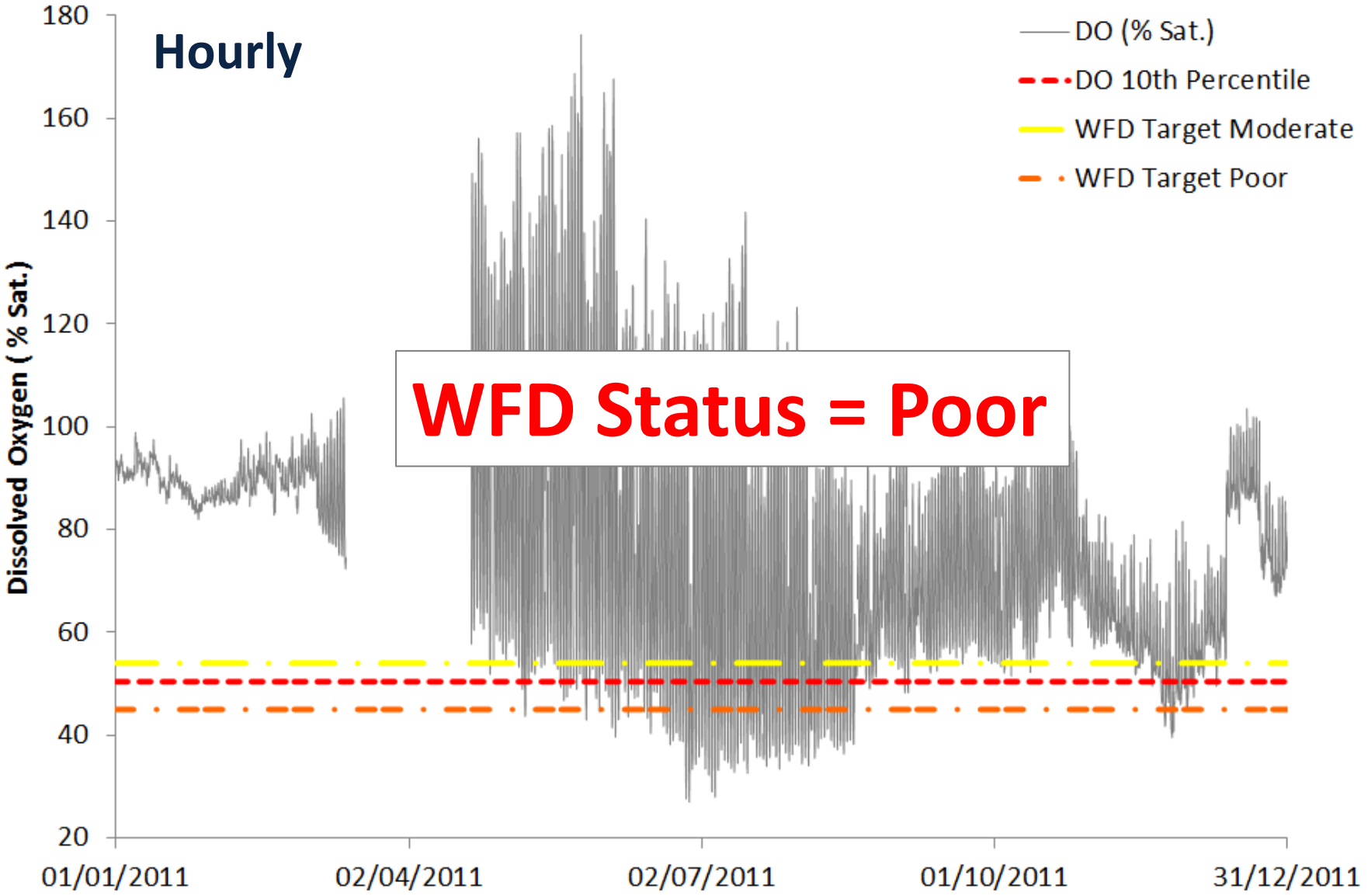

Sampling frequency

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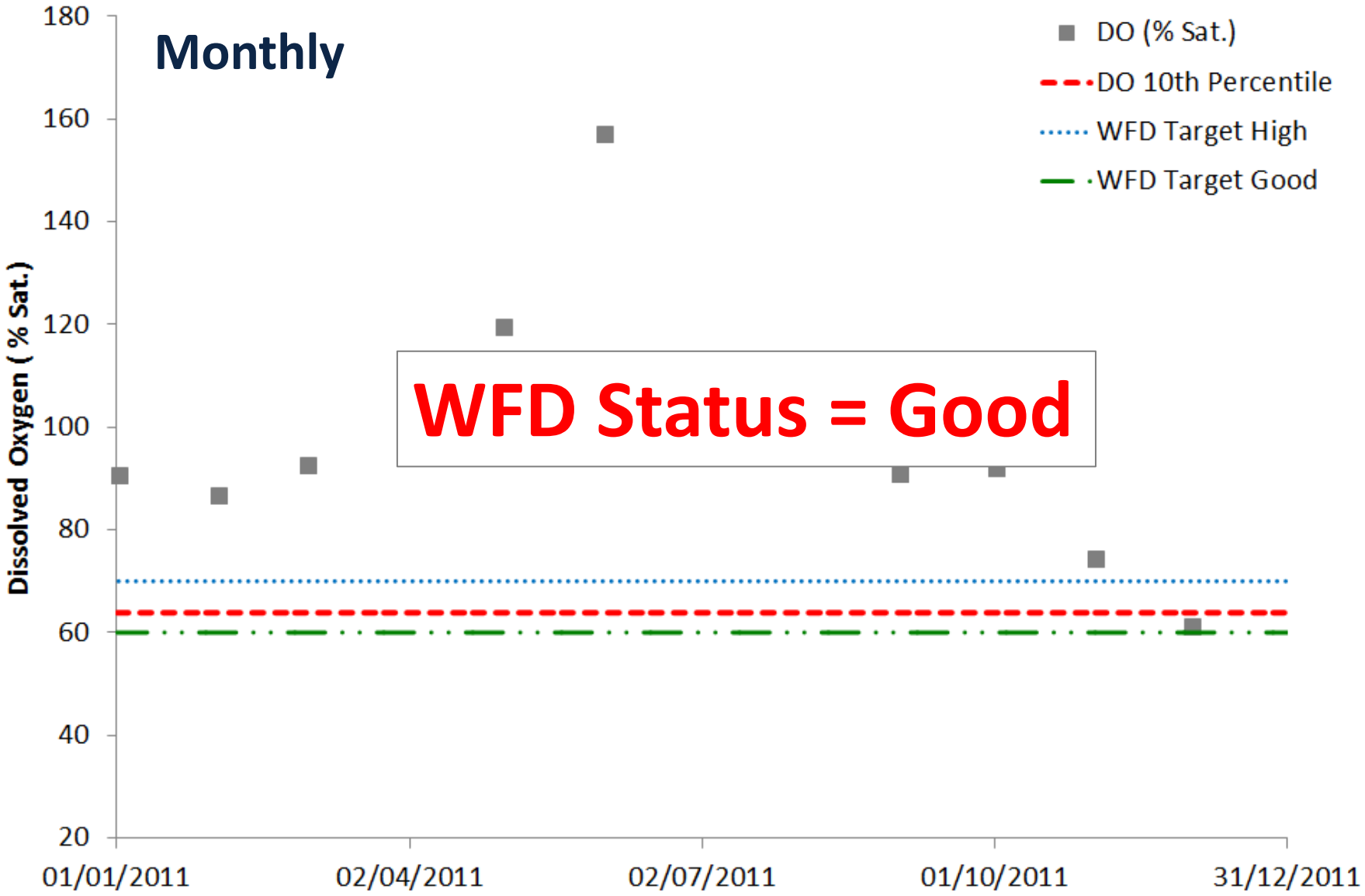

Sampling time

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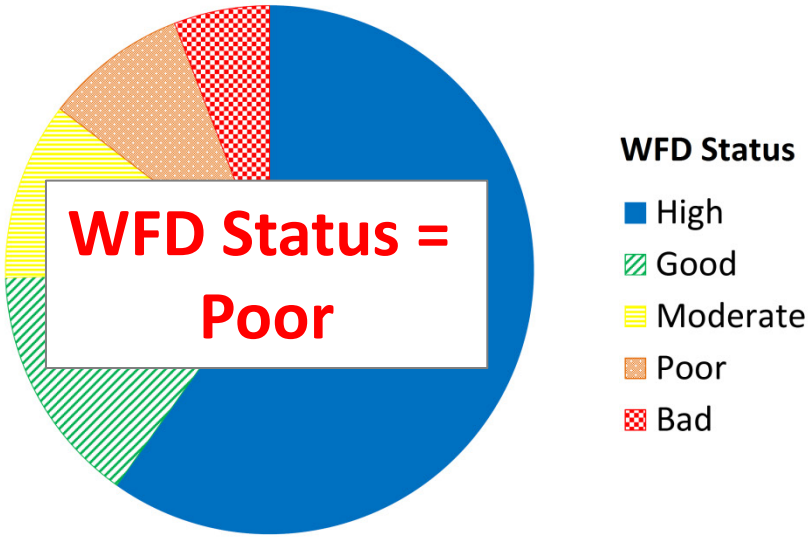
Hourly dataset:



Daily datasets:

WFD Status = Moderate	WFD Status = High	WFD Status = Good

Potential Ecological Risk

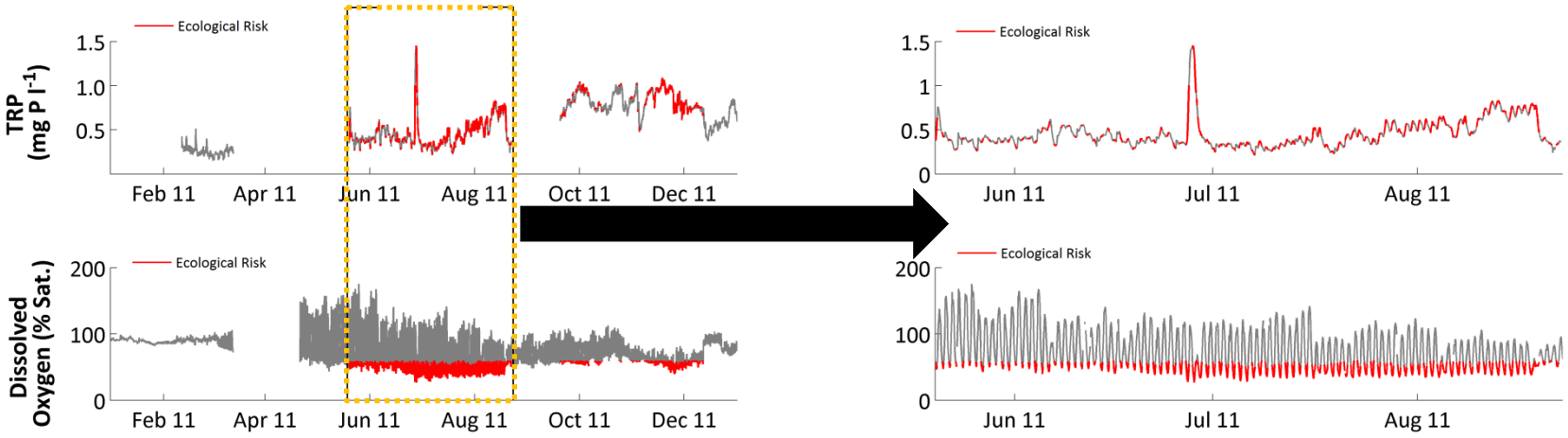
- In isolation the WFD targets do not allow regulatory authorities to identify period of potential ecological risk (PER)

Potential Ecological Risk

- Define periods of PER as:
  - Times when both the P and dissolved oxygen levels breach the WFD moderate thresholds
  - The Cut = 30.6 % samples suggest PER

Phosphorus	Dissolved Oxygen: High	Good	Moderate	Poor	Bad
High	0.0	0.0	0.0	0.0	0.0
Good	0.0	0.0	0.0	0.0	0.0
Moderate	0.7	0.0	**0.0**	**0.0**	**0.0**
Poor	52.5	15.3	**10.7**	**10.5**	**8.1**
Bad	0.5	0.5	**0.8**	**0.3**	**0.1**

Potential Ecological Risk



Low flows

High temps.

High insolation

Conclusions

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- P Targets
  - The assumption that SRP and TRP concentrations are the same does not hold in all rivers
  - Growing season mean can be significantly higher than the annual mean
  - In urbanised systems the WFD P targets may be unachievable
- Sampling regime
  - Both the sampling frequency and sample collection time can significantly affect the WFD classification
- Potential ecological risk
  - By combining the WFD targets it is possible to identify periods of time where river systems are at great risk of negative ecological effects
  - Mitigation measures can then be targeted to these periods

Recommendations

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- Define required sampling frequency
- Define sampling time window for each determinand
- Further consideration to which nutrient fractions are ecologically significant
- Further consideration to the use of growing season conditions
- Develop new guidelines to allow regulatory agency to use the WFD to identify times when river system ecology is likely to be at the greatest risk

Thank you

Questions??

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